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METHOD FOR REDUCING THE BUS LOAD IN A SYNCHRONOUS DATA BUS  
SYSTEM

Field of the invention

The present invention is related to buffering between  
5 synchronous circuits communicating via a global  
synchronous bus in particular an arrangement for reducing  
the busload in a TDM bus system.

Background of the invention

Interconnecting synchronous circuits communicating on a  
10 common synchronous bus will in cases where more than one  
transceiver for each PCB is necessary involve the use of  
buffers to avoid signal degradation and ringing on the  
bus.

For example, the lower layer of communication networks  
15 like the connectivity layer in a core network of a  
cellular environment could be seen as a layer of  
distributed resources for managing data flows. Switches  
and multiplexers are some of the main components for this  
purpose. In complex communication networks managing data  
20 of different formats and varying data rates, it is of  
great importance to keep signal degradation and bit errors  
at a minimum.

Conventionally, the switches comprise a number of serial  
inputs and outputs. The data stream of one input may be  
25 directed in its entirety to a certain output line, or it  
may consist of a mixture of time division multiplexed data  
frames that are to be distributed to several outputs. The  
different lines may be running various interfaces e.g. E1,  
E2, E3 and STM-1.

30 The switching takes place on a TDM-bus system comprising a  
data bus (DATA) (usually 8 bits) and a data clock (TDM

CLK). The time domain is divided into frames where each frame has a fixed duration (usually 125  $\mu$ s), the start of each frame is indicated with a frame synchronization signal (FSYNC). The frames are divided into a fixed number of timeslots identified by local timeslot counters. In each timeslot, data may be transmitted from a transmitter to a receiver by using time division multiplexing (TDM).

Several transmitters and receivers are able to communicate with each other over the TDM bus when every local timeslot counter is synchronised to FSYNC. Figure 1 shows how the BUS transceivers typically are connected to a backplane TDM bus. EN(1..N) are timeslot enable signals enabling the timeslots out on the TDM bus.

The architecture indicated in the figure above, i.e. a system with a large number of loads, may have problems related to degradation of received signals. The more loads a bus is subjected to, the more signal attenuation will occur.

Another drawback causing signal degradation as a result of two or more transceivers on one circuit board connected to the same TDM bus connector is the increase of stub lengths. The multi connection will cause longer stub lengths from the transceiver to the TDM bus because of the physical dimensions of the transceiver IC packages. Long stub lengths may lead to poor bus terminations that in turn may cause reflections and signal attenuation to occur, both of which may increase the bit error rate and retransmission frequency and reduce the data quality.

Another way of solving the busload problem is to have a tree structure of buffers, i.e. coupling together pairs of loads by passive buffers and, in the case of more than two loads, coupling the output of the buffers by additional buffers until only one load for connecting the TDM bus remains. However, this will introduce time delays that are

not acceptable in most applications. Only delays that are multiples of whole frames are normally accepted for the total delay from the local TDM bus out on the backplane TDM bus and back on the local TDM bus.

5    **Summary of the invention**

It is an object of the present invention to provide an arrangement that eliminates the drawbacks described above. The features defined in the enclosed claims characterize this arrangement.

10   In particular, the present invention provides an arrangement in a circuit switched node with a back plane (global) Time Division Multiplex (TDM) data bus transferring data frames of time slots between one or more Printed Circuit Boards (PCB), each including a number of  
15   loads transferring data in both RX and TX direction. This arrangement includes at least a local TDM data bus in each PCB to which the associated number of loads are connected, and an intermediate CPU controlled logic in each direction connecting a local TDM data bus to the global TDM data  
20   bus, which logic includes a FIFO buffer through which time slots of data from the local or global TDM data bus is being written in and read out to the local or global TDM data bus introducing a phase difference providing a total delay for any time slot travelling from a local TDM bus to  
25   the global TDM data bus and back to a local TDM data bus being equal to the duration of an integer number of data frames.

**Brief description of the drawings**

In order to make the invention more readily understandable, the discussion that follows refers to the  
30   accompanying drawings.

Fig. 1 illustrates a typical bus connection according to the state of the art,

Fig. 2 is an overview of the bus connection according to one embodiment of the present invention,

5 Fig. 3 shows the construction of the active buffer in the RX direction according to one embodiment of the present invention,

Fig. 4 shows the construction of the active buffer in the TX direction according to one embodiment of the present  
10 invention,

Fig. 5 shows the delay between the TDM bus and the local TDM bus when using a preferred embodiment of the present invention.

15 Description of a preferred embodiment of the present invention

The present invention provides an inventive arrangement generally solving the problems described above by introducing a local synchronous data bus (in the following referred to as a local TDM data bus) and an active buffer  
20 including a CPU controlled logic between the transceiver loads and the global synchronous data bus (in the following referred to as the global TDM data bus), as shown in Figure 2. The active buffers in the TX and RX direction together provides a time delay for data  
25 travelling from a first local synchronous data bus out on the backplane synchronous data bus and back to a second local synchronous data bus of the duration of a controllable delay, in the preferred embodiment described in the following, the exact duration of one TDM frame or  
30 an integer number of TDM frames.

In the following, a preferred embodiment of the present invention is described. However, the present invention is not limited to this exemplification. Other variations and substitution may be implemented without departing from the scope of the invention as defined in the enclosed independent claim and the associated equivalents.

According to the invention, the active buffer comprises a separate digital hardware like an ASIC or a programmable logic like FPGA, CPLD, etc., localized between the local TDM bus on the PCB board and the TDM bus in the backplane. The present invention allows a reduction of total busload on the TDM-bus, since the number of transceivers connected to the bus will be reduced from two or more to one per PCB board. The present invention also allows a reduction of the stub lengths between the TDM bus transceivers and the bus because the distance between the transceiver and the bus connector will be shorter than in the case of two or more transceivers directly connected to the connector. The buffer should include bus transceivers (i.e. bus LVDS), which are compatible with the original transceivers. They must also contain memory (RAM) to store at least one frame of data and RX and TX tables, which store information on which timeslots that are used on the individual buses.

Figure 3 and 4 shows the structures of the active buffers in the RX and TX direction, respectively. In the following, a preferred active buffer in the RX direction will be described in further detail, but an equivalent description also applies to the active buffer as shown in Figure 4, except from that the TX buffer is adapted for data flow in the opposite direction.

In addition to the data RAM, which preferably has the features of a FIFO, the active buffer includes an RX table, a "time slot counter TDM bus", a "time slot counter local bus", a write in and a read out buffer (to/from the data RAM). Data is clocked into the data RAM by the

TDM\_CLK LOCAL, which is the TDM clock of the local TDM bus, and clocked out from the RAM with the TDM\_CLK EXTERN, which is the TDM clock of the back plane TDM bus controlled by a system master circuit. The time slot

5 counters have FSYNC EXTERNAL, TDM\_CLK EXTERNAL and FSYNC LOCAL, TDM\_CLK LOCAL as inputs, respectively. The time slot counters are initialised on the corresponding FSYNCs signal, using the same frequency as their corresponding TDM\_CLKs, and keep track of which timeslot that is present

10 on the bus. The outputs from these counters (READ RX ADDR and WRITE RX ADDR) are used to address the data RAM, i.e. READ RX ADDR points at the location in the RAM in which the time slot that possibly is to be read out on the back plane TDM bus is localised, and WRITE RX ADDR points at

15 the location in the RAM in which the time slot that possibly is to be written in the data RAM should be localised. Further, TDM\_CLK EXTERN and TDM\_CLK LOCAL (as well as for FSYNC EXTERN and FSYNC LOCAL) should have the same frequency, but the phase difference should be

20 adjusted to provide the preferred delay from the local TDM bus to the back plane TDM bus. In fact, the difference between READ RX ADDR and WRITE RX ADDR, which in turn is controlled by the TDM\_CLKs and FSYNCs through the time slot counters, represents the actual delay in terms of

25 time slots through the active buffer. TDM\_CLK LOCAL and FSYNC LOCAL are preferably derived from TDM\_CLK EXTERN and FSYNC EXTERN, respectively, but it should also be possible to derive TDM\_CLK EXTERN and FSYNC EXTERN from TDM\_CLK LOCAL and FSYNC LOCAL, respectively.

30 The content of the RX table is centrally controlled by the CPU of the system concerned. One bit per time slot is assign to each time slot localisation in the data RAM. A "1" enables reading of the data at which READ RX ADDR currently is pointing from the read out buffer, and a "0"

35 disables the read out buffer. Note that the data RAM locations corresponding to the back plane time slots not being used by the load connected to the local TDM bus do

not include significant data, and the associated RX table bits are "0".

As previously indicated, the phase relationship between the local and back plane TDM bus timeslots must be in such a manner that the delay from the local TDM bus to the backplane TDM bus(RX) plus the delay from the TDM bus to the local TDM bus(TX) is exactly the duration of one frame or an integer number of frames. Furthermore, the delay ( $d$ ) between the busses must be an integer number timeslots. This is illustrated in Figure 5, and is made possible by the controllable RAM implementation described above. The Tsd indicates the phase shift in number of TS between the local and backplane bus. The number  $m$  indicates the delay for a random timeslot transmitted from the local TDM bus out on the backplane TDM bus and back on the local TDM bus again.

The present invention may advantageously be implemented in telecom switches like Base Station Controllers (BSC's) Radio Node Controllers (RNC's) or any other switches of specially purposed cellular networks or generally purposed data communication networks. The invention may be utilised connecting STM-1 PCB boards to a TDM bus using only one load per STM-1 board instead of two, so that the total load on the bus could be halved.

One of the main advantages of the present invention is that the busload is reduced, leading to smaller signal attenuation across the TDM bus.

Additionally, the stub lengths may be shortened since only one instead of e.g. two transceivers is connected to each bus connector. This means improved terminations and less signal reflection and attenuation.

Furthermore, although an additional buffer step is introduced due to the intelligent feature of the buffer,

no combinatorial delays are introduced, only synchronous delays that are multiples of whole frames.

The present invention also provides simplified PCB routing in terms of simplified wiring and shorter stub lengths.



**Abbreviations**

PCB Printed Circuit Board

RX Receive direction (from local TDM bus to backplane  
TDM bus)

5 TX Transmit direction (from backplane TDM bus to local  
TDM bus)

FPGA Field Programmable Gate Array

ASIC Application Specific Integratet Circuit

TDM Time Division Multiplex